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Molluscs from the diets of commercially exploited fish off the coast of Victoria, Australia

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ABSTRACT

The diets of fifty-two commercially exploited species of fish, mostly collected off the coast of Victoria, were investigated through examination of stomach contents. Molluscs were found in the diets of twenty-six species but only provided a major proportion (>30% by number, weight or volume) of the diets of eight species. Cephalopods, gastropods and bivalves were found in the diets of twenty-one, six and five species respectively. Arrow squid, *Nototodarus gouldi,* was the most widely identified of the species consumed, being found in the diets of eight species and being taken from the stomachs of fish collected over the whole geographical range of the survey. However, for those fish found to be major consumers of molluscs it was octopus, rather than squid, which provided the major molluscan component of the diet.

INTRODUCTION

In 1942 Cotton published a list of cephalopods taken from the stomachs of fish caught in south-east Australia. Since Cotton's paper there has, until recently, been little particular interest in the occurrence of cephalopods, or of molluscs in general, in fish diets. Reports on the diets of commercial fish species found in southern Australia have appeared, but the occurrence of molluscs in the diet has received only passing mention (Fairbridge, 1951; Olsen, 1954; Thomson, 1954, 1959; Serventy, 1956; Winstanley, 1978).

However, within the last three to four years the possibility of establishing a fishery for the arrow squid, *Nototodarus gouldi,* off the coast of Victoria has been investigated (Machida, 1980). Concurrent with these investigations has been an interest in understanding the importance of squid in the diets of commercial fish species. A general survey of the diets of commercial fish has been undertaken (Coleman, 1982). The present paper reports on the occurrence of molluscs in the diets of the species studied and makes a preliminary estimate of the importance of arrow squid. The majority of fishes examined were caught off the coast of Victoria, but the tuna examined were from New South Wales and South Australia.

LEGENDS

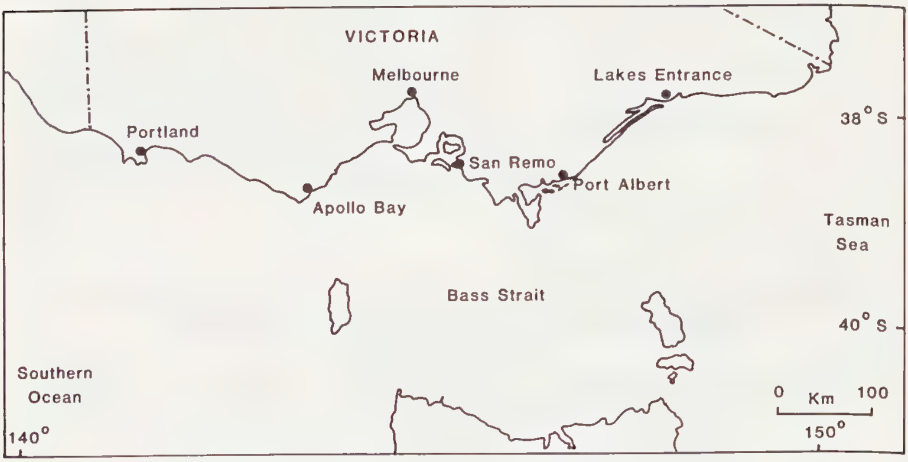

Figure 1. Sampling localities along the coast of Victoria.

MATERIALS AND METHODS

Diets were investigated through examination of stomach contents. Fish or fish stomachs were obtained and preserved in neutral formalin by travelling on commercial fishing vessels from Lakes Entrance, San Remo and Portland (Fig. 1) and subsampling the catch. Fish were obtained from co-operatives at Lakes Entrance and Port Albert, and from the Melbourne fish market. Shark fishermen from Port Albert, San Remo and Apollo Bay were given preservative, plastic bags and marking pens and asked to bring back individually bagged, preserved and labelled stomachs. Tuna stomachs were obtained from SAFCOL in Melbourne and were from fish landed in New South Wales (port unknown) and Port Lincoln in South Australia.

In the laboratory each stomach was cut open. The contents were sorted into individual food items and identified to the lowest possible taxonomic level. As far as possible the number, weight and volume of each food item was determined. In some cases, because of the nature of the stomach contents or their poor state of preservation, measurements were not possible.

Gastropods and bivalves were considered as part of the diet if the shells had flesh attached, if the shells were of relatively fresh appearance and were largely free of encrusting material, or if (for bivalves) the valves were still hinged together. Shell fragments could occasionally be separated into species. In some cases fragments could be used to estimate the number of individuals represented; otherwise, for the purpose of data analysis, the presence of fragments was counted as one individual.

Items were lightly blotted, to remove excess preservative, before being weighed. Volume measurements were made either by measuring the displacement of water in a measuring cylinder or by spreading the material to an even depth over a grid and counting the squares covered. The second method was used where food consisted of many small items or of amorphous or detrital material. Only one method of determining volume was used for the contents of any one stomach.

Analysis of the composition of the diet was carried out on the stomach contents of each species in each sample and also on the stomach contents of each species summed over all samples. The numbers of stomachs with and without food were determined.

The frequency with which a food item occurred was determined by expressing the number of stomachs containing that item as a percentage of all stomachs containing food. The proportion (by number, weight and volume) of each food item in each stomach was determined and the means and standard deviations of the proportions were calculateld.

RESULTS

The diets of fifty-two species of fish were investigated (Complete list in Appendix). In all, 2042 stomachs, of which 1270 (62.2%) contained food, were examined. There were large variations between species in the number of stomachs examined (Appendix; Table 1). These variations reflect commercial availability. Species such as gummy and school sharks, which form a major part of the commercial catch, were well represented in the survey whereas species such as whiskery shark, which occur as an incidental catch, were obtained only in small numbers.

Analysis of diets by number, weight and volume gave similar results, and results averaged over all samples gave essentially the same picture of the relative importance of different food items as did the results from individual samples. Unless otherwise stated, therefore, the following description is given in terms of volume composition averaged over all samples.

Molluscs were found in the diets of twenty-six species (Tables 1-4). Cephalopods (Tables 1-3) were the most widely occurring molluscs being found in the stomachs of twenty-one species. Gastropods and bivalves (Table 4) were taken from the stomachs of six and five species respectively.

Cephalopods formed the major portion of the diets of seven species, gummy shark, whiskery shark, school shark, endeavour dogfish, piked dogfish, toothy flathead and yellow-tail kingfish, providing, in these species, at least a third of the stomach contents and occurring in at least half of the stomachs examined.

Cephalopods were of moderate occurrence, 11-21% by number, weight and volume, in toothed whiptail and John dory. In deepwater flathead cephalopods were only 8.3% of the diet by volume but were 15.4% by number and weight. By frequency of occurrence cephalopods may be considered as of moderate occurrence, 11-28%, in the diets of six species, elephant shark, toothed whiptail, John dory, deepwater flathead, albacore and yellowfin tuna.

By number, weight and volume, and by frequency of occurrence, cephalopods were only of minor occurrence ($<$10%) in the diets of saw shark, nannygai, gemfish, rock flathead, latchet, butterfly gurnard, jackass morwong and southern bluefin tuna.

Arrow squid, *Nototodarus gouldi,* was the most widely identified species of cephalopod. It was identified from the stomachs of eight species (Table 2) and was taken from fish throughout the whole geographical range of the survey.

Although *N. gouldi,* was of relatively widespread occurrence, it did not constitute a major part of the diet in any species. In gummy and school sharks, for which large samples were obtained, *N. gouldi* contributed an overall average of 4-6% of the diet. However, within individual samples higher values, up to 12% for gummy shark, and up to 26% for school shark, were obtained. Similarly, although the overall frequencies of occurrence of *N. gouldi* were 14% and 21% for gummy and school sharks respectively, within individual samples up to 63% of gummy shark and up to 67% of school shark were found to have eaten arrow squid.

By comparison with that of *N. gouldi,* the occurrence of other species of squid and cuttlefish was restricted. Most contributed less than 5% of the diet and most occurred only in one or two species from one or two samples. *Pyroteuthis* was found only in gemfish from Portland; *Cheiroteuthis* and squid of the family Enoploteuthidae were found only in yellowfin tuna from Port Lincoln; dumpling squid, Sepiolidae, were found in butterfly gurnard from Lakes Entrance; and *Euprymna tasmanica* was found in rock flathead from Port Albert. *Sepia* was exceptional in that either *Sepia rex* or remains identifiable only as *Sepia* were found in the stomachs of fish landed at all Victoria ports visited except Portland. Unidentifiable squid was found in the diets of several species. Except in the case of toothy flathead, unidentifiable squid provided a relatively minor part of the diet.

Octopus were found in the diets of ten species although specifically identifiable remains were only taken from gummy shark, whiskery shark and school shark (Table 3). *Octopus australis* and *O. pallidus* were taken from sharks landed at Port Albert, San Remo and Apollo Bay; *O. flindersi* was taken from shark landed at San Remo and Apollo Bay; *O. dofleini* and *O. superciliosus* were taken from shark landed at Port Albert; and *O. macropus* was taken from shark landed at San Remo. Only unidentifiable octopus remains were taken from albacore landed in New South Wales; Yellowtail kingfish landed in Lakes Entrance and toothed whiptail, toothy flathead, latchet and jackass morwong landed at Portland.

Octopus formed 50-70% of the stomach contents of school shark, whiskery shark and yellowtail kingfish, and almost 30% of the stomach contents of gummy shark. The frequency of occurrence of octopus in the stomachs of these species was also relatively high. *Octopus australis* was the major identifiable octopus in the diet of whiskery shark, and *O. pallidus* was the major identifiable octopus in the diets of gummy and school sharks.

Gastropods and bivalves were found in the diets of nine species and, with two exceptions, the frequency of occurrence and proportion in the diet were low (Table 4). In many cases shells had been crushed and it was not possible to establish the identity of all fragments. The list in Table 4 therefore probably under-estimates the actual number of species present in the stomachs examined.

Bivalves provided a particularly high proportion of the diet of elephant shark. Although only a small number of stomachs was examined, the contents of each were similar and included a large variety of shell fragments.

Bivalves were also of particular importance in the stomachs of snapper although in this case the very small sample size may have given a false impression of their importance. Only one stomach contained bivalve fragments, but as they constituted the bulk of the stomach contents, and as only three stomachs with food were examined, average values for frequency of occurrence and proportion in the diet remained high.

DISCUSSION

The present study has shown the consumption of molluscs to be of wide occurrence amongst commercial fish species off the coast of Victoria. The twenty-six species found to eat molluscs represent perhaps 30-50% of commercial species and certainly include some of major importance.

Only about twenty species of molluscs could be identified to genus or below. The large number of unidentifiable shell fragments suggests the actual number consumed to be greater than this. But even allowing for a two or threefold increase in the number actually identified, the number of species found would still be small by comparison with the number of mollusc species recorded from Victoria (Macpherson and Gabriel, 1962). However, while only a small number of mollusc species may be consumed, some make a very significant contibution to fish diets.

Cephalopods appear to be the most important molluscs in terms of their contribution to fish diets. They were found in the diets of more species than were gastropods and bivalves and were a major item in the diets of seven species. From the identifications that were possible, these major consumers of cephalopods seem to be exploiting octopus rather than squid.

Nototodarus gouldi was identified from the diets of eight fish species although its occurrence is probably wider than this: the stomachs of some fish species examined contained only unidentifiable cephalopod remains; and local fishermen report that yellowtail kingfish eat arrow squid. Although *N. gouldi* was of relatively widespread occurrence it was not found to be a major dietary item for any species. In particular, in the major commercial species gummy and school sharks *N. gouldi* provided an overall average of only 4-6% of the diets; even if all unidentified squid in the diet were considered to be *N. gouldi*, the percentage of arrow squid in the diet would still, overall, remain relatively low. However, within individual samples of these shark species, high values for the proportion and for the frequency of occurrence of squid in the diet were found. These high values may indicate the opportunistic feeding of gummy and school sharks when squid are particularly abundant. Serventy (1956) found similar evidence for the opportunistic feeding of southern bluefin tuna on *N. gouldi*.

Factors which have a significant bearing on the importance of dietary items, but which were not directly investigated, are the rates at which they are consumed and digested and their calorific content. Soft-bodied animals may be rapidly digested and so their importance in the diet, when determined solely in terms of number weight or volume, may be underestimated (Pillay, 1953). However, in the present study the fact that large amounts of octopus were consistently found in the diets of some species suggests that the generally low occurrence of squid in the diet is not just an artefact arising from their soft-bodied nature but does reflect actual consumption rates.

Croxall and Prince (1982) report that squid, because they have little fat, have a relatively low calorific content. In terms of importance in the diet, deficiences in the calorific content of an item may be compensated for by factors such as availability or the absence of skeletal material (Paine and Vadas, 1969; Carefoot, 1973). The present study found no evidence to show that such factors are operating to make arrow squid of general importance to any of the fish species studied. There was, however, slight evidence, as noted above, to show that on occasion squid may be particularly readily taken as prey.

Compared wtih cephalopods, gastropods and bivalves were of limited occurrence in fish diets although bivalves appear to be of particular importance to elephant shark and snapper. Some doubt attaches to the dietary analyses for snapper because only a small number of stomachs (with food) was examined and the contents of the stomachs differed markedly. The diet of snapper has been most intensively studied in New Zealand (Godfriaux, 1974) and this work showed crustaceans to be most important although the diet was found to be extremely varied and to include several species of molluscs.

The primary aim of the present work was to gain some understanding of the importance of arrow squid, *Nototodarus gouldi*, in the diets of commercial fish species off the coast of Victoria. The evidence provided by the study is that none of the species investigated is dependant on squid as a food source. Although molluscs are consumed by a wide range of fish species, relatively few were found to have molluscs as a major item in the diet. Whereas fish and crustaceans were found to be the major items in the diets of twenty-five and fourteen species respectively (Coleman, 1982), only eight species had molluscs as a major food item; and in no case was *N. gouldi* a major item. In contrast, octopus were found to contribute significantly to the diets of gummy and school sharks, two major species of the commercial marine fishery in Victoria.

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LITERATURE CITED

Carefoot, T.H., 1973. Feeding, food preference, and the uptake of food energy by the supralittoral isopod *Ligia pallasii* Mar. Biol. 18: 228-236.

Coleman, N., 1982. *The occurrence of arrow squid Nototodarus gouldi (McCoy, 1888) in the diets of commercially exploited fish off the coast of Victoria.* Internal Report No. 11, Marine Science Laboratories, Queenscliff, Victoria.

Cotton, B.C., 1942. Cephalopods from stomach contents of fish from east and south Australia Trans. Roy. Soc. S. Aust. 83-84.

Croxall, J.P., and Prince, P.A., 1982. Calorific content of squid (Mollusca: Cephalopoda). Br. Antarct. Surv. Bull. 55: 27-31.

Fairbridge, W.S., 1951. The New South Wales tiger flathead *Neoplatycephalus macrodon* (Ogilby) 1. Biology and age determination. Aust. J. Mar. Freshwater Res. 2: 117-178 (+ pl. 1-4).

Godfriaux, B.L., 1974. Food of snapper in Western Bay of Plenty, New Zealand. N.Z. J. Mar. Freshwater Res. 8: 473-504.

Machida, S., 1980. *Report of the squid survey by the FV Hoyo Maru No. 67 in south east Australian Waters 1979/80.* Report No. 22, Japan Marine Fishery Resource Research Centre, Tokyo.

Macpherson, J.H., and Gabriel, C.H., 1962. *Marine Molluscs of Victoria.* Melbourne University Press.

Olsen, A.M., 1954. The biology, migration, and growth rate of the school shark, *Galeorhinus australis* (Macleay) (Carcharinidae) in south-eastern Australian waters. Aust. J. Mar. Freshwater Res. 5: 353-410.

Paine, R.T., and Vadas, R.L., 1969. Calorific values of benthic marine algae and their postulated relation to invertebrate food preference. Mar. Biol. 4: 79-86.

Pillay, T.V.R., 1953. A critique of the methods of study of food of fishes. J. Zool. Soc. India 4: 185-200.

Serventy, D.L., 1956. The southern bluefin tuna, *Thunnus thynnus maccoyii* (Castelnau) in Australian waters. Aust. J. Mar. Freshwater Res. 7: 1-43.

Thomson, J.M., 1954. The organs of feeding and the food of some Australian mullet. Aust. J. Mar. Freshwater Res. 5: 469-485.

Thomson, J.M., 1959. Some aspects of the ecology of Lake Macquarie N.S.W. with regard to an alleged depletion of fish. Aust. J. Mar. Freshwater Res. 10: 365-374.

Winstanley, R.H., 1978. Food of the trevalla *Hyperoglyphe porosa* (Richardson) off south-eastern Australia (NOTE). N.Z. J. Mar. Freshwater Res. 12: 77-79.

APPENDIX: List of fish species investigated.

The number in brackets after each name shows the number of stomachs containing food which were examined. Species marked with an asterisk are those found to include molluscs in the diet.

Spotted catshark (1)
Asymbolus analis
(Ogilby)

Gummy shark (113)*
Mustellus antarcticus
Guenther

Whiskery shark (5)*
Furgaleus ventralis
(Whitley)

School shark (109)*
Galeorhinus australis
(Macleay)

Endeavour dogfish (1)*
Centrophorus scalpratus
McCulloch

Piked dogfish (4)*
Squalus megalops
(Macleay)

Saw shark (28)*
Pristiphorus sp.

Elephant shark (6)*
Callorhyuchus milii
Bory de.St. Vincent

Cucumber fish (1)
Chlorophthalmus nigripinnis

Garfish (11)
Hyporhamphus melanochir
(Valenciennes)

Tooth whiptail (7)*
Lepidorhynchus denticulatus
Richardson

Blue Grenadier (17)
Macruronus noveazelandiae
Waite

Bearded cod (11)
Lotella callarias
Guenther

Ribaldo (11)
Mora moro
Risso

John dory (9)*
Zeus faber L.

Mirror dory (4)
Zenopsis nebulosus
(Temminch and Schlegel)

Silver dory (53)
Cyttus australis
(Richardson)

Nannygai (98)*
Centroberyx affinis
(Guenther)

Sandpaper fish (5)
*Paratrachichthys traill*i
(Hutton)

Sea mullet (9)
Mugil cephalus L.

Barracouta (1)
Thyrsites atun
(Euphrasen)

Gemfish (64)*
Rexea solandri
(Cuvier and Valenciennes)

Warehou (1)
Seriolella brama
(Guenther)

Deep sea trevalla (1)
Hyperoglyphe antarctica
(Carmichael)

Toothy flathead (5)*
Neoplatycephalus speculator
Klunzinger

Sand flathead (43)*
Platycephalus bassensis
Cuvier and Valenciennes

Rock flathead (12)*
Platycephalus laevigatus
Cuvier and Valenciennes

Deep water flathead (13)*
Platycephalus conatus
Waite and McCulloch

Tiger flathead (70)
Neoplatycephalus richardsoni
Whitley

Yank flathead (3)
Platycephalus caerulopunctatus
McCulloch

Latchet (25)
Pterygotrigla polyommata
(Richardson)

Red gurnard (4)*
Chelidonichthys kumu
(Lesson and Garnot)

Butterfly gurnard (43)*
Paratrigla vanessa
(Richardson)

Red ocean perch (43)
Heliocolenus papillosus
(Bloch and Schneider)

Gurnard perch (1)
Neosebastes pandus
(Richardson)

Ling
Genypterus blacodes
(Richardson)

Horse mackerel (26)
Trachurus declivis
(Jenyns)

Yellowtail scad (29)*
Trachurus mccullochi
Nichols

Trevelly (17)
Usacaranx georgianus
(Curvier and Valenciennes)

Yellowtail kingfish (2)*
Seriola grandis
Castelnau

Red mullet (12)
Upeneichthys porosus
(Cuvier and Valenciennes)

Long-finned pike (12)
Dinolestes lewini
(Griffith)

King George whiting (9)
Sillaginodes punctatus
(Cuvier and Valenciennes)

School whiting (46)
Sillago bassensis
(Cuvier and Valenciennes)

Snapper (3)
Chrysophrys auratus
(Schneider)

Jackass morwong (98)*
Nemadactytus macropterus
(Bloch and Schneider)

Long-snouted boarfish (1)
Pentaceropsis recurvirostris

Barred grubfish (3)
Parapercis allporti
(Guenther)

Albacore (21)*
Thunnus alalunga
(Bonnaterre)

Southern bluefin tuna (38)*
Thunnus maccoyii
(Castelnau)

Yellow-fin tuna (33)*
Thunnus albacares
(Bonnaterre)

Velvet leatherjacket (10)
Meuschenia australis
(Donovan)

Table 1. Total cephalopods in the diets of commercially exploited fish off the coast of Victoria.
The number in brackets after the name of each fish denotes the number of stomachs with food. For each entry, the upper figure shows the frequency of occurrence and the lower figure shows percentage of cephalopods in the diet (Mean ± ISD) by volume.

Fish	Cephalopods in the diet	Fish	Cephalopods in the diet
Gummy shark (113)	69.9 43.0 ± 42.4	Toothy flathead (5)	60.0 50.0 ± 57.7
Whiskery shark (5)	80.0 79.8 ± 44.6	Rock flathead (12)	9.1 9.1 ± 30.2
School shark (109)	90.8 67.3 ± 38.7	Deepwater flathead (13)	15.4 8.3 ± 28.9
Endeavour dogfish (1)	100 39.7 ± 0	Latchet (25)	4.8 0.2 ± 0.8
Piked dogfish (4)	50.0 42.3 ± 50.4	Butterfly gurnard (43)	4.8 2.4 ± 15.4
Saw shark (28)	7.1 4.4 ± 19.2	Yellowtail kingfish (2)	50.0 50.0 ± 70.7
Elepehant shark (6)	16.7 8.3 ± 20.4	Jackass morwong (97)	1.1 1.1 ± 10.3
Toothed whiptail (7)	28.6 17.3 ± 37.3	Albacore (21)[1]	14.3 7.6 ± 24.1
John dory (9)	11.1 11.1 ± 33.3	Southern bluefin tuna (38)[2]	8.1 5.5 ± 22.5
Nannygai (98)	1.0 1.0 ± 10.2	Yellowfin tuna (33)[3]	15.2 1.3 4.2
Gemfish (64)	9.4 7.9 ± 27.2		

1. From New South Wales
2. From New South Wales and South Australia
3. From South Australia

Table 2. Squid and cuttlefish in the diets of commercially exploited fish off the coast of Victoria. *See also caption to Table 1.*

Fish	*Sepia rex*	*Sepia*	*Euprymna tasmanica*	Sepiolidae	*Nototodarus gouldi*	Oommastrephidae	*Pyroteuthis*	*Cheiroteuthis*	Enoploteuthidae	Unidentified squid
Gummy shark (113)					14.2 4.4 ± 15.1					3.5 3.5 ± 18.3
Whiskery shark (5)					20.0 20.0 ± 44.7					
School shark (109)		2.8 0.8 ± 5.8			21.1 6.0 ± 17.5					5.5 2.6 ± 14.7
Saw shark (28)	7.1 4.1 ± 16.1				3.6 3.6 ± 18.9					3.6 0.8 ± 4.2
John Dory (9)					11.1 11.1 ± 33.3					
Nannygai (98)		1.0 1.0 ± 10.2								
Gemfish (64)					4.7 4.7 ± 21.3		1.6 *			1.6 1.6 ± 12.5
Toothy flathead (5)										20.0 20.0 ± 44.7
Rock flathead (12)			9.1 9.1 ± 30.2							
Butterfly gurnard (43)				2.4 2.4 ± 15.3						
Albacore (21)[1]						4.8 2.5 ± 11.5				
Southern bluefin tuna (38)[2]					5.4 5.3 ± 22.5	2.7 0.2 ± 1.1				
Yellowfin tuna (33)[3]					9.1 0.5 ± 2.1			33.3 0.6 ± 3.7	3.0 *	

1. From New South Wales
2. From New South Wales and South Australia
3. From South Australia

* Mean volume < 0.05

Table 3. Octopus in the diets of commercially exploited fish off the coast of Victoria. *See also caption on Table 1.*

Fish	*Octopus australis*	*Octopus dofleini*	*Octopus flindersi*	*Octopus macropus*	*Octopus pallidus*	*Octopus superciliosus*	Unidentifiable Octopus
Gummy shark (113)	2.7		2.7	0.9	11.5	0.9	37.2
	1.6 ± 12.3		2.2 ± 13.6	0.7 ± 7.7	7.9 ± 24.9	0.2 ± 1.8	17.3 ± 31.4
Whiskery shark (5)	40.0						20.0
	39.8 ± 54.5						20.0 ± 44.7
School shark (109)	1.8	1.8			22.0		54.1
	1.5 ± 11.1	1.7 ± 12.3			17.4 ± 35.0		27.3 ± 37.5
Toothed whiptail (7)							14.3
							3.1 ± 8.1
Toothy flathead (5)							40.0
							25.0 ± 50.0
Latchet (25)							4.8
							0.2 ± 0.8
Butterfly gurnard (43)							2.4
							*
Yellowtail kingfish (2)							50.0
							50.0 ± 70.7
Jackass morwong (97)							1.1
							1.1 ± 10.3
Albacore[1] (21)							4.8
							0.3 ± 4.1

1. From New South Wales

* Mean volume <0.05

Table 4. Gastropods and bivalves in the diets of commercially exploited fish off the coast of Victoria. *See also caption to Table 1.*

Fish	Total Gastropoda	*Gazameda subsquamosa*	*Sigaretotrema umbilicata*	*Nassarius burchardi*	Turrid sp. 1	Total Bivalvia	*Nuculana crassae*	*Leionucula obliqua*	Glycymeridae	*Glycymeris striatularis*	Mytilidae	*Pratulum thetidis*	*Chioneryx cardiodes*	*Callianaitis disjecta*
Gummy shark (115)						3.5 0.3 ± 3.1		1.8 0.3 ± 3.1						
School shark (109)						1.8 0.5 ± 4.8		0.9 0.5 ± 4.8						
Elephant shark (6)	16.7 2.7 ± 6.5					83.3 68.1 ± 36.1	16.7 2.7 ± 6.5		16.7 2.7 ± 6.5		16.7 2.7 ± 6.5	16.7 2.7 ± 6.5	16.7 2.7 ± 6.5	
Sand flathead (43)	4.9 3.8 ± 17.7			1.4 *										
Red gurnad (4)	25.0 0.3 ± 0.5			25.0 0.3 ± 0.5										
Ling (76)	1.4 *													
Yellowtail scad (29)	3.6 *	3.6 *												
Snapper (3)						33.3 25.2 ± 43.7				33.3 25.2 ± 43.7				
Jackass morwong (97)	4.3 1.3 ± 10.6		1.4 1.4 ± 11.6		1.4 *	2.6 11.5 ± 11.6					1.3 0.3 ± 2.3			

* Mean volume < 0.05